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Title #PRA1130
High Temperature Electro-insulating Materials (silicones)

Short Title
High Temperature Electro-insulating Materials

Technology Area
Ceramics / MAT-CER

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Research Institute Where the Above Persons Belong
State Scientific Research Institute of Chemistry and Tecnology of Organoelement Compounds (GNIIKhTEOS)

1. Present Status of Research

Fundamentals for the development of high-heatconducting composites on the ground of synthetic polymer binders and heatconducting disperse inorganic fillers have been developed. A complex of silicone high-heatconducting materials have been obtained on the basis of the developed principles. The complex involves:
-non-drying pastes
-elastomeric compositions, vulcanizing at room temperature (RTV) of two types:
- RTV-I and RTV-II.

Heat conductivity of the proposed materials significantly out performs similar materials offered at the market. The properties of the available at the market materials and those proposed by us are presented in the Table attached. The properties of the promising materials are presented therewith. The achievement of these properties will require additional funding.

Application:
electronics, electrotechnics, tool, and machine-building.

Purpose:
- good heat removal due to high heat conduction of materials;
- improvement of thermal contact in heat releasing element-radiator system;
- electroinsulation;

- sticking (bonding) and installation of electroradio elements and printed circuits (in the event of use of RTV-1 and RTV-2 materials);
- encapsulation and sealing of parts of devices (RTV-2) for protection against diversified factors;

Provide:
- optimal thermal regimes of devices and instruments function due to high heat removal;
- reliable electric insulation of device parts;
- technologically effective mounting of parts of devices and instruments;
- maintenance;
- improvement of characteristics of weight and overall dimensions;
- improvement of quality and reliability.

Performances:
- temperature range from -60^{0}C to +150^{0}C (pastes)
-60^{0}C to +200^{0}C
250^{0}C (elastomers RTV-1,RTV-2)
- humidity and weather resistance;
- biological and chemical inert;
- corrosion passivity;
- vibration-proof;
- high adhesion to metals, glass ceramics (in event RTV-1 and RTV-2).

As there is a number of know-how no results of this research have been published.

Cooperation with foreign partners is possible in the following directions:
1. Transfer of know-how of licenses for the production of available silicones.
In the framework of the Agreement the buyer can be provided with basic raw materials of required quality.
2. Joint research concerning the production of materials with properties similar or better than those shown in the table as promising ones.

Estimated cost of such investigations is $ 100,000-120,000.

The results can be jointly patented. Joint research regarding high-heat-conductive materials on the ground of organic (silicone-free) binders of various classes which are interesting for the Customer. Cost of the development and the possibility for joint patenting are to be discussed in the process of further contacts. An experimental base for the foregoing research including high-precision instruments for the determination of heat- conductivity coefficient λ (w/m$\cdot$deg K) in a wide temperature range and test materials consistency.

Comparative characteristics of heat-conduction for some type of silicon heat conductive materials manufacturing by different companies

Country, company	Material type	Brand	Heat conductive

			λ w/m deg K
Russia	non-drying	available	1.8-2.0
		perspective	2.2-2.3
	RTV-1	available	1.8-2.0
		perspective	2.2-2.3
	RTV-2 paste	available	1.7-1.8
		perspective	1.9-2.0
	RTV-2 potting	available	0.8-1.0
		perspective	1.2-1.4
USA			
Dow Corning	non-drying	DC 340	0.42
	RTV-1	96-080 RTV	0.8
Emmerson and Cuming Inc.	non-drying	EccotermTC-4	1.3
	RTV-2 paste	Eccosil 4952	1.07
		Eccosil 4852	1.15
		Eccosil TP-51	1.25
Germany			
Wacker	non-drying	P 12	0.8
	RTV-1	SLM 76247	1.2
	RTV-2 paste	Semicosil 980 TC	0.9
		Silgel 674	1.2
	RTV-2 potting	RTV-ME 675	1.2
		RTV-ME 676	0.8
Japan			
Toshiba	non-drying	YG-6111	0.63
		YG-6260	0.84
Shin-Etsu	RTV-1	KE 12RTV	0.84

Emerson & Cuming
a National Starch & Chemical Company

Internet Address:
www.emersoncuming.com

Technical Data Sheet

STYCAST® 4952

Thermally Conductive, RTV Silicone Encapsulant

Key Feature:	Benefit:
• High thermal conductivity	• Dissipation of heat from embedded components
• High temperature resistance	• Casting can survive severe environmental conditions

Product Description:

STYCAST 4952 is a RTV condensation cure, thermally conductive, silicone rubber potting compound. It yields a flexible, thermally conductive material having excellent electrical properties and high temperature resistance. STYCAST 4952 is readily pourable and is room temperature curable.

Applications:

STYCAST 4952 is designed for potting and encapsulation of components that require the dissipation of heat and the high temperature properties and low stress of a silicone compound.

Instructions For Use:

Thoroughly read the information concerning health and safety contained in this bulletin before using. Observe all precautionary statements that appear on the product label and/or contained in individual Material Safety Data Sheets (MSDS).

To ensure the long term performance of the potted or encapsulated electrical / electronic assembly, complete cleaning of components and substrates should be performed to remove contamination such as dust, moisture, salt, and oils which can cause electrical failure, poor adhesion or corrosion in an embedded part.

This RTV silicone product is based on condensation cure chemistry and will cure in contact with most materials without cure inhibition. This product is not recommended for use in closed molds or sealed molds which could prevent its exposure to moisture or the escape of reaction by-products required to complete the cure. In addition, catalysts used to cure this product may cause corrosion of copper and other sensitive metals.

Some filler settling is common during shipping and storage. For this reason, it is recommended that the contents of the shipping container be thoroughly mixed prior to use. Power mixing is preferred to ensure a homogeneous product.

Accurately weigh the liquid RTV silicone and catalyst into a clean container in the recommended ratio. To facilitate the addition of catalyst, the use of a medicine dropper which has been previously calibrated to determine the number of drops per gram is recommended. Working life and cure time are shortened as the amount of catalyst is increased. Low catalyst concentrations are recommended for applications requiring thick sections or use at temperatures in excess of 125°C.

Blend components by hand, using a kneading motion, for 2-3 minutes. Scrape the bottom and sides of the mixing container frequently to produce a uniform mixture. If possible, power mix for an additional 2-3 minutes. Avoid high mixing speeds which could entrap excessive amounts of air or cause overheating of the mixture resulting in reduced working life.

To ensure a void-free embedment, vacuum deairing should be used to remove any entrapped air introduced during the mixing operation. Vacuum deair mixture at 1-5 mm mercury. The foam will rise several times the liquid height and then subside. Continue vacuum deairing until most of the bubbling has ceased. This usually requires 3-10 minutes.

In general, silicone materials exhibit outstanding release properties and will not adhere to most substrates. If adhesion is required, apply a thin, uniform coating of PRIMER S 11 to the desired clean, dry substrates. Allow the PRIMER S 11 to dry for 30-60 minutes at room temperature before applying this silicone material.

Pour mixture into cavity or mold. Further vacuum deairing in the mold may be required for critical applications.

Properties of Material As Supplied:

Property	Test Method	Unit	STYCAST 4952 - Part A	Catalyst 50
Chemical Type			Silicone	Silicone catalyst
Appearance	Visual		Red liquid	Clear liquid
Density	ASTM-D-792	g/cm^3	2.20	
Brookfield Viscosity	ASTM-D-2393	Pa.s cP	35 35,000	0.085 85

Properties of Material As Mixed:

Property	Test Method	Unit	Valu
Mix Ratio - Amount of Catalyst 50 per 100 parts of STYCAST 4952		By Weight	0.1 - 0.4
Working Life (100 g @ 25°C)	ERF 13-70		60
Density	ASTM-D-792	g/cm^3	2.20
Brookfield Viscosity	ASTM-D-2393	Pa.s cP	35 35,000

Cure Schedule:

Cure at any one of the recommended cure schedules. Where use at temperatures above 125°C is anticipated, a post cure schedule of 1-2 hours at 25-30°C increments up to the highest expected use temperature is recommended to properly condition the silicone rubber.

Temperature (°C)	Cure Time (hours)
25	16-24
65	2-4

Properties of Material After Application:

Property	Test Method	Unit	Value
Hardness	ASTM-D-2240	Shore A	70
Tensile Strength	ASTM-D-412	mPa psi	4.5 650
Elongation	ASTM-D-412	%	70
Tear Strength	ASTM D-624	N/m pli	4,400 25
Coefficient of Thermal Expansion	ASTM-D-3386	10^{-6}/°C	162
Thermal Conductivity	ASTM-D-2214	W/m.K Btu-in/hr-ft^2-°F	1.0 7.0
Temperature Range of Use		°C	-65 to +260
Dielectric Strength	ASTM-D-149	kV/mm V/mil	21.7 550
Dielectric Constant @ 1 mHz	ASTM-D-150	-	5.2
Dissipation Factor @ 1 mHz	ASTM-D-150	-	0.01
Volume Resistivity @ 25°C	ASTM-D-257	Ohm-cm	>10^{14}

Storage and Handling:

The shelf life of STYCAST 4952 is 4 months at 25°C. For best results, store in original, tightly covered containers. Storage in cool, clean and dry areas is recommended. Usable shelf life may vary depending on method of application and storage conditions.

Health and Safety:

The STYCAST 4952, like most industrial compounds, possesses the ability to cause skin and eye irritation upon contact. Handling this product at elevated temperatures may also generate vapors irritating to the respiratory system.

Good industrial hygiene and safety practices should be followed when handling this product. Proper eye protection and appropriate chemical resistant clothing should be worn to minimize direct contact. Consult the Material Safety Data Sheet (MSDS) for detailed recommendations on the use of engineering controls and personal protective equipment.

This information is only a brief summary of the available safety and health data. Thoroughly review the MSDS for more complete information before using this product.

Attention Specification Writers:

The values contained herein are considered typical properties only and are not intended to be used as specification limits. For assistance in preparing specifications, please contact Emerson & Cuming Quality Assurance for further details.

■ Underfills Solder Alternatives C.O.B. Materials Film Adhesives Thermal Interfaces ■

Emerson & Cuming
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STYCAST® 4952

Two Component, RTV Silicone Rubber With Superior Thermal Conductivity

Key Feature	Benefit

Product Deacription :

STYCAST 4952 is a red pourable two component RTV silicone based composition that has a higher thermal conductivity than the more conventional silicones. It may be cured at room temperature or at elevated temperature to a flexible silicone rubber capable of withstanding exposure to temperatures of 260°C and up to 315°C for short periods. STYCAST 4952 is a 100 % reactive material. No solvents are contained therein.

Applications :

STYCAST 4952 bonds well to most other silicones. Where a bond to other substrates is desired, apply a thin coat of PRIMER S 11 to the substrate and allow it to dry for 30 - 60 minutes. Low humidity conditions may require longer drying times. When dry, apply the STYCAST 4952.

STYCAST 4952 is particularly recommended for potting and encapsulating components from which heat is to be dissipated.

Instructions For Use :

1 Prior to adding catalyst, thoroughly mix the STYCAST 4952 in the container in which it is received to insure uniformity. On long standing, there will be some tendency for the filler to settle to the bottom.
2. Weigh out the desired amount of STYCAST 4952, and add CATALYST 50 in the ratio of 0,2 g of Catalyst to 100 g of STYCAST 4952. The range may be varied from 0,1 g to 0,5 g with the rate of cure increasing somewhat with increasing amount of catalyst.
3. Mix the CATALYST 50 into the STYCAST 4952. Power stirring is preferred. Pot life is 1 to 4 hours depending on the amount of catalyst used.
4. Deair under vacuum to insure a void free casting. A recommended procedure is to evacuate until the head of bubbles breaks. Break the vacuum and remove the container Mix a second time, while scraping the resin mix from the sides of the container. Evacuate a second time.
5. Pour into cavity to be filled. If the cavity is complex and contains small gaps to be filled, it is suggested that it be half filled and again subjected to vacuum. On removal from the vacuum chamber, the cavity is completely filled and the resin is allowed to cure.
6. Cure can be effected by allowing to stand at room temperature ovemight. The unit can then be handled. Full properties will develop in 5 - 6 days at room temperature. Cure time may be shortened by curing initially 4 hours at 65°C. A post cure of 3 hours at 120°C is recommended. (Where service temperatures above 120°C are anticipated, use a longer cure at low temperature e.g 48 hours at 65°C followed by 4 hours each at 30°C increments up to service temperature).

Properties Of Material As Supplied :

Property	Test Method	Unit	Value
Chemistry			silicone
Appearance	Visual		red
Density	ASTM-D-792	g/cm³	2,2 - 2,3
Viscosity at 25°C	ASTM-D-2393	Pa.s	30 - 40

Cure Schedule :

Please refer to the instructions for use above.

Properties Of Material After Application :

Property	Test Method	Unit	Value
Hardness	ASTM-D-2240	Shore A	85 minimum
Compressive Strength	ASTM-D-695	MPa	TBD
Elastic Modulus, Compressive	ASTM-D-695	MPa	TBD
Flexural Strength	ASTM-D-790	MPa	TBD
Flexural Modulus	ASTM-D-790	MPa	TBD
Tensile Strength	ASTM-D-638	MPa	4 – 5
Impact Strength	ASTM-D-256	J/cm	TBD
Thermal Conductivity	ASTM-D-2214	W/m.K	0,94
Coefficient Of Linear Thermal Expansion	ASTM-D-3386	10^{-6} K^{-1}	1,6
Linear Shrinkage During Cure	ASTM-D-2566	%	TBD
Volume Resistivity	ASTM-D-257 at 25°C	Ohm.cm	TBD
Dielectric Constant at 1 MHz	ASTM-D-150		5,2
Dissipation Factor at 1 MHz	ASTM-D-150		TBD
Loss Tangent at 1 MHz	ASTM-D-150		0,01
Dielectric Strength	ASTM-D-149	kV/mm	21,6
Moisture Absorption In 24 Hours	ASTM-D-570	%	TBD
Machinability			TBD
Service Temperature	ASTM-D-794	°C	TBD
Elongation	ASTM-D-412	%	70 – 100
Tear Strength	ASTM-D-624	N/m	750 minimum

Storage And Handling :

Store STYCAST 4952 in well sealed, closed containers at temperatures between 18°C and 25°C

Storage Temperature (°C)	Usable Shelf Life (months)
18 to 25	6

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STYCAST® 4952

Two Component, RTV Silicone Rubber
With Superior Thermal Conductivity

Health & Safety :

It is recommended to consult the Emerson & Cuming product literature, including material safety data sheets, prior to using Emerson & Cuming products. These may be obtained from your local sales office.

Attention Specification Writers :

The technical information contained herein is consistent with the properties of the material and should not be used in the preparation of specifications, as it is intended for reference only. For assistance in preparing specifications, please contact your local Emerson & Cuming office for details. Please contact Emerson & Cuming Quality Assurance for test method details.

(STYCAST® is a registered trademark of National Starch and Chemical Company)

(STYCAST 4952 was previously called ECCOSIL 4952)

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